Thesis
Reports
Frissell,
S.S.

Non-Game bird and mammal Habitats in the Sub-Alpine Fir Forests of Western Montana.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INT Missoula FSL

REPLY TO: 4040 Cooperation

April 27, 1979

SUBJECT: Supplement No. 73 - University of Montana

TO: David E. Blackner, Assistant Director

The final report on Supplement No. 73-University of Montana has been submitted:

> "Non-game bird and mammal habitats in the subalpine fir forests of western Montana."

This has been a particularly long and involved agreement because it required two extensions and finally became clear that the student would be unable to complete the dissertation and report.

Despite the delays in completion of the work, this is a substantial report which should be of considerable immediate value in management and as a planning tool for future research by RWU-1705.

I have enclosed one copy for the Station library file.

Jack Lyon

L. JACK LYON
Project Leader, RWU-1705

Enclosure

cc: Sidney Frissell, UM

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BIRD-HABITAT RELATIONS WITHIN SUB-ALPINE FOREST COMMUNITIES IN WESTERN MONTANA

Final report to the U.S. Forest Service
Intermountain Forest and Range Experiment Station
Suppl. #73 to 12-11-204-1

April 15, 1979

by

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Interest in non-game wildlife is growing throughout North America. Activities such as bird-watching, wildlife photography, and general nature study are becoming increasingly popular. Such trends have caused resource managers to direct increased attention toward the preservation and enhancement of non-game wildlife populations.

Greater concern for non-game wildlife has also been stimulated by more sophisticated environmental impact assessments. Resource managers now recognize they must evaluate the impacts of land use practices on all organisms, and not just the more prominent big game animals.

Whether the focus is on developing management plans to enhance a population or on assessing the impact of a proposed land use practice, questions arise such as: where does species X occur, what species are found in forest type Y, and what will happen if we manipulate type Y in a certain way?

Answering these questions requires understanding the habitat relations of the animal species. Unfortunately, although wildlife research has been in progress for many years, relatively little information is available on the habitat relations of non-game species, beyond general statements that species X is found in "coniferous forests" or "grasslands."

Habitat information is particularly lacking for non-game birds. Studies of bird-habitat interaction have increased in recent years but often these investigations have been highly mathematical in approach. Consequently, the results produced are difficult to interpret in terms of management implications.

This project was designed to produce information on non-game bird habitats and to present this information in a form of immediate and direct use in resource management decision-making. The study concentrated on the sub-alpine forests of western Montana and examined the relationship of bird communities to Habitat Types (Pfister, et al. 1979), successional stages, and stand structure within these forests. The specific objectives were:

1. Determine how non-game birds respond to forest communities delineated by various Abies lasiocarpa Habitat Types.
2. Assess the relationships between bird communities and several successional stages of forest development.
3. Investigate the effect of foliage structure on bird communities.

METHODS

Site selection

Nine study areas were selected, all within the Lolo Creek drainage, approximately 11 miles south of Missoula (Figure 1). Precise location maps for the study areas are contained in Appendix A.

These study areas were selected to represent a variety of subalpine fir habitat types and a full range of successional stages from a recent clearcut through an old growth subalpine fir forest. Shortly after initiation of the study, site VIII was drastically modified by timber harvesting and was eliminated from use.

Plot layout

A 7-hectare plot (approximately 17 acres) was located at each study site. These plots measured 200 m x 350 m and were overlain by a system of roughly surveyed grid lines spaced at 50 meter intervals. These grid lines served as routes for the breeding bird census and the grid intersections became vegetation sample points.

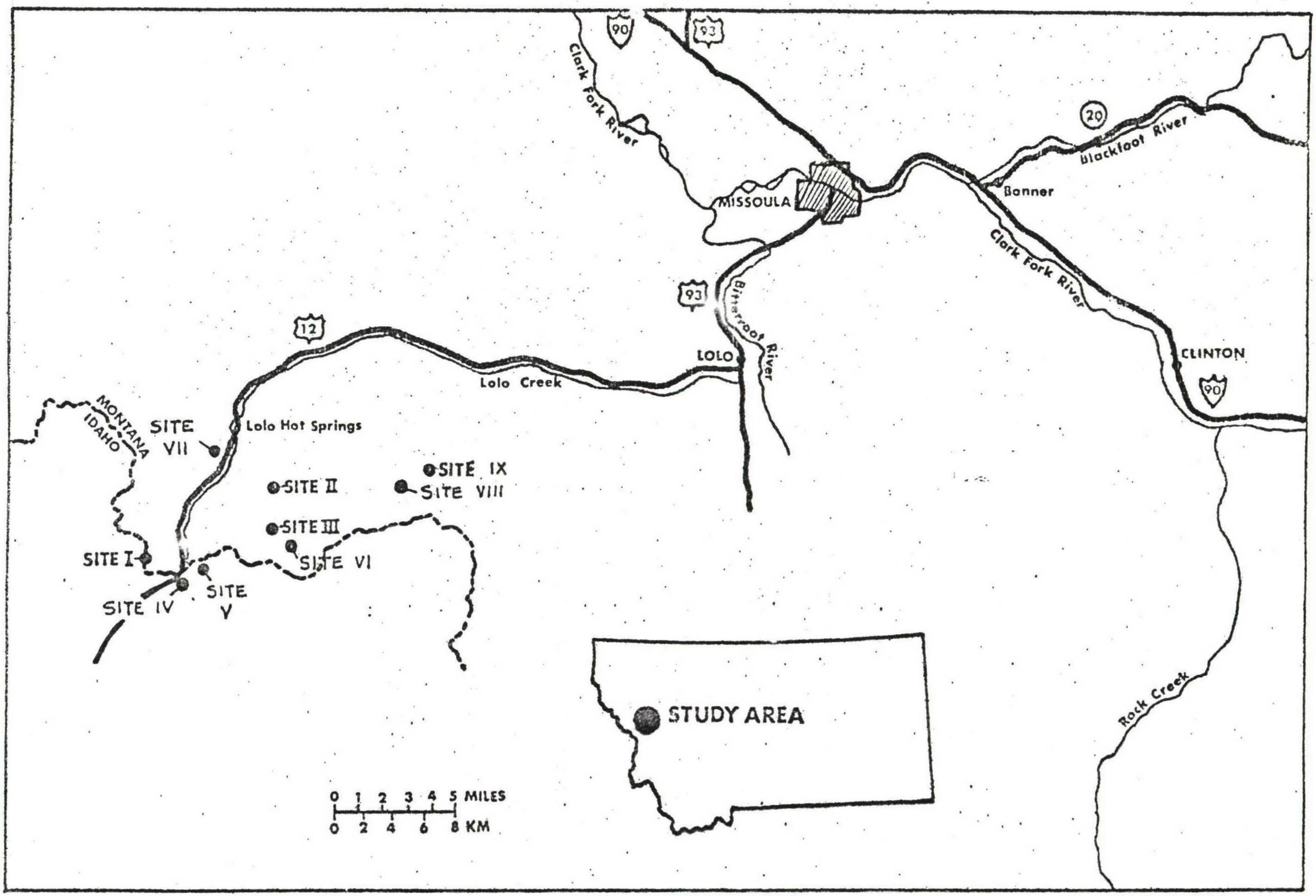

90
93
Clark Fork River
20
Blackfoot River
MISSOULA
Bonner
Clark Fork River
93
Bitterroot River
12
LOLO
CLINTON
90
Lolo Creek
MONTANA
IDAHO
SITE VII
Lolo Hot Springs
SITE IX
SITE II
SITE VIII
SITE III
SITE I
SITE VI
SITE V
SITE IV
STUDY AREA
Rock Creek
0 1 2 3 4 5 MILES
0 2 4 6 8 KM

Figure 1. Location of study areas.

Vegetation measurement

Vegetation measurements were made at each intersection point of the 50 m grid system. This approach produced 40 sampling points in each study area. The following data were collected at each point:

1. Basal areas of trees, by species, as determined by variable-radius cruising techniques.
2. Diameter of trees, by species, for each tree selected in Step 1.
3. The vertical foliage profile was broken into layers, identified as:
    herb
    shrub
    conifer, regeneration
    understory (low tree canopy)
    overstory (upper tree canopy)

    The upper and lower limits of each layer was noted and the % foliage cover of the layer estimated in total, and, in the shrub layer, by major species.
4. Habitat Type surrounding each sample point.

Breeding Bird Censuses

Breeding bird censuses were completed on each study plot during the Springs of 1976 and 1977. Each area was visited from 6 to 9 times.

The 50 m. grid lines served as census routes and the locations of each singing male bird or other useful observation were noted on daily field maps, in relation to the grid intersections. These observations were later transferred to individual species maps, accumulating all observations for the season.

Territories of breeding pairs were identified on the species maps, using such indicators as repeated observations of singing males in proximity, records of simultaneous singing by adjacent males (indicating two separate territories) and observations of territorial "border disputes."

Data analysis

Territorial maps of each bird species found in a study area were overlayed on the grid system for the same area to determine which vegetation sample points (grid intersections) fell within the territories. Data from these sample points were averaged to produce a description of the vegetational characteristics of breeding habitat selected by each bird species. With this approach, the following characteristics were summarized:

a. Percent cover, height and foliage volume (m^3/.01 h) of:

    herb layer
    shrub layer
    conifer regeneration layer
    tree layer

b. Total vegetation foliage volume (m^3/.01 h)

c. Basal area/A. of tree layer, by diameter classes and species

d. Stems/acre of trees, by diameter classes and species

e. Dominant species in each layer

f. Habitat type

RESULTS

Vegetational characteristics of study areas

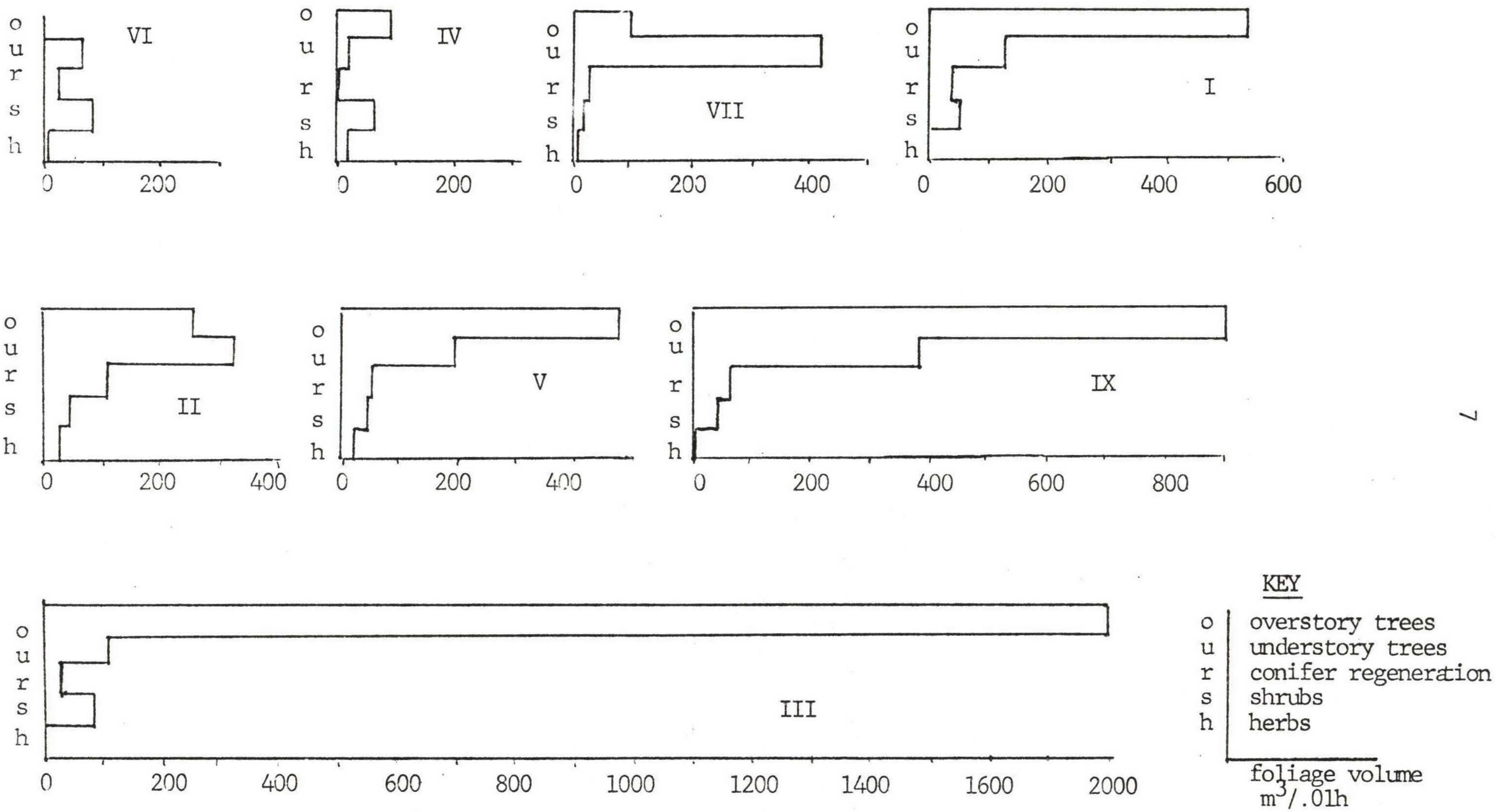
The vegetation structural characteristics of each of the eight study areas are summarized in Table 1, with the areas ordered according to successional development from clearcut (VI) to old-growth (III). Tree data are summarized in this Table for all species. Stand tables are provided in Appendix B for each study area by tree species.

Profile diagrams are presented in Figure 2 for foliage volumes within each vegetation layer. These diagrams provide a graphic picture of the greatly varied vertical foliage structure found on the eight study areas.

Table 1. Summary of vegetation characteristics on study plots.

	STANDS							
	VI	IV	VII	I	II	V	IX	III
Tree Layer								
Height (m)	4	7	9	13	16	17	24	34
Volume m^3/.01h	66	89	96	537	254	476	898	1799
Stems/A								
0-4	226	82	2439	204	1313	1126	839	445
4-15	27	41	206	262	239	315	254	113
15-30	0	0	3	2	2	5	11	42
30+	0	0	0	0	0	0	0	1
TOTAL	253	123	2648	468	1554	1446	1104	601
Basal Area ft^2/A								
0-8"	9	7	85	37	55	65	49	13
8-34"	0	13	25	96	64	77	108	186
TOTAL	9	20	110	133	119	142	157	199
Shrub layer								
Height (m)	1.5	1.4	0.6	0.8	0.9	0.9	0.7	1.1
Volume m^3/.01h	81	59	14	48	47	50	42	83
Dom. Spp (cover)	Alsi	Mefe	Xete	Xete	Legl.	Vagl	Vagl	Vagl
2	Vagl	Alsi	Libo	Mefe	Libo	Mefe	Xete	Mefe
3	Mefe	Setr	Legl.	Vasc.	Vasc.	Vasc.	Alsi.	Libo
Cover %	54	43	22	50	44	51	65	75
Total Veg. Volume m^3/.01h								
Conifer	90	114	355	566	614	626	1090	1397
Deciduous	100	74	21	59	63	71	47	87
TOTAL	190	188	376	625	677	698	1137	1484
No. of vegetation layers	3	4	5	5	5	5	5	5

Figure 2. Profile diagrams of foliage volume within each of five vertical layers of canopy.



Relationships of breeding birds to habitat types

Twelve habitat types were identified on the eight study areas. All types are in the Abies lasiocarpa (Abla) series.

1. Luzula hitchcockii (Vaccinium scoparium phase) - Luhi/Vasc.
2. Luzula hitchcockii (Menziesia ferruginea phase) - Luhi/Mefe
3. Vaccinium caespitosum - Vaca
4. Xerophyllum tenax - Xete
5. Vaccinium scoparium (Calamagrostis rubescens phase) - Vasc/Caru
6. Linnea borealis (Xerophyllum tenax phase) - Libo/Xete
7. Calamagrostis canadensis - Caca
8. Menziesia ferruginea - Mefe
9. Galium triflorum - Gatr.
10. Clintonia uniflora (Xerophyllum tenax phase) - Clun/Xete
11. Clintonia uniflora (Clintonia uniflora phase) - Clun/Clun
12. Clintonia uniflora (Menziesia ferruginea phase) - Clun/Mefe

Table 2 illustrates the frequency distribution of these types over the eight study areas.

The data available to illustrate relationships between breeding bird habitat selection and Habitat Types consists of counts of the number of sample points (grid intersections) within each species' collective territory area, which fell in each of the various Habitat Types. These numbers alone have little comparability. Considerable variation occurs in the size of each species' individual territories (and consequently, their collective territory areas) and in the areas covered by each Habitat Type. This situation makes data interpretation difficult.

The simplest approach to evaluating territory-Habitat Type relationships is to only note whether the bird species was present and breeding within the Habitat Type. In other words, which types were included within the breeding habitat?

Table 2. Frequency of occurrence of various Habitat Types on the study areas.

	Study Areas								Freq. of occurrences of HT on all study areas
	I	II	III	IV	V	VI	VII	IX	
			-- percent frequency --						
Luhi/Vasc	48								6.4
Luhi/Mefe	52								7.1
Vaca							63		8.1
Xete		3			5			71	10.1
Vasc		3							0.3
Libo		3						5	1.0
Caca		35		3	38	17	37		16.2
Mefe		17		43	20	13			11.8
Gatr						2			0.3
Clun/Xete								16	2.0
Clun/Clun		32			5	28		5	8.1
Clun/Mefe		7	100	54	32	40		3	28.6
	100	100	100	100	100	100	100	100	100.0

Table 3 illustrates this sort of analysis. The Habitat Types in this table have been arranged from left to right in order of increasing potential vegetation productivity.[1] Simple ordination techniques (involving only visual inspection of the data) were used to arrange the bird species in a sequence related to the order of Habitat Types.

Several apparent relationships are indicated by these "presence" data alone. It is obvious that the potentially more productive types (Abla/Caca, Mefe and Clun) support the largest number of breeding bird species. The six types of higher potential average 11 species per type as opposed to 4 species per type in the six lower productivity types.

A large amount of species variability exists in the number of different habitat types found acceptable as breeding areas (Table 4). Juncos, Townsend's Warblers and Swainson's Thrushes are either quite adaptable or do not recognize Habitat Types as defining different breeding habitat. However, eleven species are fairly confined in Habitat Type utilization, breeding in four or fewer of the twelve types sampled. As the amplitude of Habitat Type acceptibility narrows the tendency is toward utilizing the more productive types.

Table 5 illustrates the frequency with which breeding birds utilized each of the twelve Habitat Types. To correct for variable sample sizes, the raw frequency distribution of each species over the types has been weighted by dividing by the frequency with which that type was available on all study areas.

It is again obvious that most species find suitable breeding territories in more than a single Habitat Type. The frequency distributions indicate most species are more common in one or two types but are also fairly well distributed over several other types. In summary, the bird species might be categorized as

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[1] Arno, S. 1979. Personal communication.

HABITAT TYPE

Bird * species	Luhi		Vaca	Xete	Vasc	Libo	Caca	Mefe	Gatr	Clun		
	Vasc	Mefe								Xete	Clun	Mefe
DJ	X	X		X	X	X	X	X		X	X	X
ST	X	X		X			X	X		X	X	X
YbS		X										
TW		X		X	X	X	X	X	X	X	X	X
RbN		X	X				X					X
GcK		X		X			X			X	X	X
RcK				X			X	X			X	
MC				X		X				X	X	
WW				X	X		X	X		X	X	X
CS				X	X		X	X		X	X	X
WT				X			X	X		X	X	X
FS					X			X			X	X
WV							X	X			X	X
WcS							X	X			X	X
LS							X				X	X
BhG							X				X	X
WFc							X				X	X
MW								X				X
No. of species	2	6	1	9	5	3	14	11	1	8	15	15

Table 3. Presence of breeding birds within habitat types.

* Bird species abbreviations: DJ-Dark-eyed Junco, ST-Swainson's Thrush, YbS-Yellow-bellied Sapsucker, TW-Townsend's Warbler, RbN-Red-breasted Nuthatch, Gck-Golden-crowned Kinglet, RcK-Ruby-crowned Kinglet, MC-Mountain Chickadee, WW-Wilson's Warbler, CS-Chipping Sparrow, WT-Western Tanager, Fox Sparrow, WV-Warbling Vireo, WcS-White-crowned Sparrow, LS-Lincoln's Sparrow, BhG-Black-headed Grosbeak, WFc-Willow Flycatcher, MW-MacGillivray's Warbler.

Table 4. Range of adaptability of habitat types by breeding birds.

Bird Species	Number of Habitat Types Utilized (Total=12)		
	Wide latitude	Moderate	Narrow latitude
Dark-eyed Junco	10		
Townsend's Warbler	10		
Swainson's Thrush	8		
Wilson's Warbler		7	
Chipping Sparrow		7	
Western Tanager		6	
Golden-crowned Kinglet		6	
Red-breasted Nuthatch			4
Ruby-crowned Kinglet			4
Mountain Chickadee			4
Fox Sparrow			4
Warbling Vireo			4
White-crowned Sparrow			4
Lincoln's Sparrow			3
Black-headed Grosbeak			3
Willow Flycatcher			3
McGillivray's Warbler			2
Yellow-bellied Sapsucker			1

HABITAT TYPE
(Frequency %)

Bird	Luhi									Clun		
Species	Vasc	Mefe	Vaca	Xete	Vasc	Libo	Caca	Mefe	Gatr	Xete	Clun	Mefe
DJ	1.67	1.51		1.06	6.00	1.80	0.55	0.60		3.55	0.88	1.18
ST	2.19	0.65		0.23			1.01	0.39		1.15	0.57	1.79
YbS		14.08										
TW		0.28		2.04	3.33	2.00	1.52	0.42	3.33	2.95	1.21	1.06
RbN		4.69	1.37				0.68					1.55
GcK		2.01		3.89			0.44			5.35	2.64	0.25
RcK				1.98			1.85	0.85			4.94	
MC				2.83		14.30				21.40	1.76	
WW				0.19	6.33		1.18	1.47		0.95	2.37	1.35
CS				2.64	22.33		0.41	0.57		3.35	0.83	1.40
WT				1.52			0.79	0.65		2.55	0.63	1.88
FS					47.67			1.21			1.76	2.00
WV							0.84	1.15			3.92	1.43
WcS							0.71	2.28			2.85	1.35
LS							2.57				5.15	0.58
BhG							1.54				3.09	1.75
WFc							0.48				6.64	1.35
McGW								5.65				1.16

Table 5. Frequency distribution of breeding birds within Habitat Types. (Frequencies of occurrence of each species is weighted by dividing by the frequency of the Habitat Type).

follows:

Obvious concentration in one Habitat Type

Yellow-bellied Sapsucker
Fox Sparrow
McGillivray's Warbler
Chipping Sparrow
Willow Flycatcher

Some concentration in one or two types but otherwise well distributed

Dark-eyed Junco
Red-breasted Nuthatch
Golden-crowned Kinglet
Ruby-crowned Kinglet
Mountain Chickadee
Wilson's Warbler
Warbling Vireo
Lincoln's Sparrow

Widely distributed, no strong concentration

Swainson's Thrush
Townsend's Warbler
Western Tanager
White-crowned Sparrow
Black-headed Grosbeak

To further examine the relationship between territory selection and habitat productivity, the twelve Habitat Types and phases were categorized as low, moderate, or high productivity (yield capability) according to data in Pfister et al. 1977. This approach categorized Luhi/Mefe and Luhi/Vasc as low yield capability, Clun/Clun and Clun/Mefe as high yield, and the remaining types as moderate yield. Frequency values for each bird species were summarized for each yield category (Table 6). The bird species have been arranged in order of increasing dependence on higher productivity sites.

Relationships of breeding birds to forest successional stages

As noted earlier, each of the eight study areas was selected to represent a different successional stage of the subalpine-fir forest, from clearcut to old-

Table 6. Frequency of breeding birds within Habitat Types grouped by potential productivity (yield capability)1/

Species	Low	Med	High
	Potential Productivity		
	----Frequency----		
YbS	14.08		
RbN	4.69	2.50	1.55
ST	2.84	2.78	2.36
DJ	3.18	13.56	2.06
GcK	2.01	9.68	2.89
TW	0.28	15.59	2.27
FS		48.88	3.76
MC		38.53	1.76
CS		29.30	2.23
WW		10.12	3.72
mcGW		5.65	1.16
WT		5.51	2.51
RcK		4.68	4.94
WcS		2.99	4.20
LS		2.57	5.73
WV		1.99	5.35
BhG		1.54	4.84
WFc		0.48	7.99

1/ Rating of yield capability from Pfister, et al, 1977.

growth forest. The stages represented were described in Table 1, Figure 1, and Appendix B.

The number of pairs per 100 hectares of each breeding species was determined for each successional stage (study area). These data are included in Table 7, with the study areas arranged in logical successional order from Site IV (clearcut) through Site III (old-growth). This arrangement also represents generally increasing total foliage volume.

In the following section, the vegetation structure of each stage is characterized and the breeding birds in the area identified as found exclusively, primarily, or secondarily,

Site VI - Clearcut with scattered remnant of Engelmann spruce, lodgepole pine and subalpine fir, 2 to 8" dbh; a few 8-15" dbh. Well-developed shrub layer (54% cover) averaging 1.5 m. high, of alder, Menziesia and Vaccinium globulare.

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
Willow Flycatcher	White-crowned Sparrow	--
Black-headed Grosbeak	Warbling Vireo	
	Lincoln's Sparrow	
	Wilson's Warbler	

Site IV - Partial cut in subalpine fir, leaving a sparse stand of fir 4-15" dbh. Moderate shrub layer (43% cover), averaging 1.4 m. high, of Menziesia and alder.

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
McGillivray's Warbler	--	White-crowned Sparrow
		Warbling Vireo
		Wilson's Warbler
		Fox Sparrow

Site VII - Dense stand of lodgepole pine with some larch, mostly less than 4" dbh. Shrub layer low and sparse beargrass and Ledum.

Birds: No breeding birds confirmed for this site. Birds seen on the area but not consistently included:

Rufous Hummingbird
Gray Jay
Dark-eyed Junco
Townsend's Warbler
Yellow-rumped Warbler
Spruce Grouse
Western Tanager
Solitary Vireo
Cooper's Hawk

Table 7. Breeding bird species ordinated against study areas arranged in successional sequence.

	Study Area							
	VI	IV	VII	I	II	V	IX	III
	-No. pairs per 100 hectares-							
WF	104							
BhG	21							
WcS	54	39						
WV	68	21						
LS	36				15			
WW	110	40			54	79		17
McGW		11						
FS		14			21			6
YbS				7				
TW				21	326	100	136	150
GcK				14		14	79	4
DJ				50	105	71	39	83
ST				33	35	33		54
RBN					11			8
CS					79		29	33
RcK						21		
WT						54	50	83
MC							36	
	6	5	0	5	8	7	6	9
#pairs/ 100h.	393	125	0	125	646	372	369	438

Site I - Mature lodgepole pine with much Engelmann spruce and subalpine fir, mostly less than 15" dbh. Moderate shrub layer of beargrass and *Menziesia*.

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
Yellow-bellied Sapsucker	--	Townsend's Warbler
		Golden-crowned Kinglet
		Dark-eyed Junco
		Swainson's Thrush

Site II - Mixed Engelmann spruce, subalpine fir, with some western larch, up to 15" dbh. Considerable spruce and lodgepole pine regeneration. Moderate shrub layer of *Ledum* and *Vaccinium scoparium*.

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
--	Fox Sparrow	Lincoln's Sparrow
	Townsend's Warbler	Wilson's Warbler
	Dark-eyed Junco	Swainson's Thrush
	Red-breasted Nuthatch	
	Chipping Sparrow	

Site V - Subalpine fir stand with fair amount of Engelmann spruce, mostly less than 15" dbh, some stems between 15-30" dbh. Moderate shrub layer of *Vaccinium globulare* and *Menziesia ferruginea*.

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
Ruby-crowned Kinglet	--	Wilson's Warbler
		Townsend's Warbler
		Golden-crowned Kinglet
		Dark-eyed Junco
		Swainson's Thrush
		Western Tanager

Site IX - Mixed stand of Douglas-fir, lodgepole pine, subalpine fir, Engelmann spruce and western larch, with Douglas-fir dominant. Diameters range to 30" dbh. Regeneration is primarily lodgepole, subalpine fir and Douglas-fir. Moderate shrub cover of *Vaccinium globulare* and beargrass.

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
Mountain Chickadee	Golden-crowned Kinglet	Townsend's Warbler
		Dark-eyed Junco
		Chipping Sparrow
		Western Tanager

Site III - Old-growth Engelmann spruce with fair amount of larch and Douglas-fir. Diameters range up to 30" dbh. and occasionally larger. Regeneration is primarily subalpine fir. Shrub layer fairly extensive (75% cover) of Vaccinium globulare and Menziesia ferruginea (averaging 1.1 m. tall).

Birds:

Exclusive Habitat	Primary Habitat	Secondary Habitat
	Swainson's Thrush	Fox Sparrow
	Western Tanager	Townsend's Warbler
		Golden-crowned Kinglet
		Dark-eyed Junco
		Red-breasted Nuthatch
		Chipping Sparrow
		Wilson's Warbler

Relationships of breeding birds to habitat structure

The summarization of vegetation data from all grid intersection sample points within a bird species' territories provides information on the habitat structure selected by the species.

Table 8 illustrates the presence of breeding birds in each of seven classes of total foliage volume. In general, the pattern follows that for bird species distribution over the eight sites arranged in successional sequence (Table 7), i.e., total foliage volume increase parallels successional development.

The four bird species found in the lowest foliage volume areas (MacGillivray's Warbler, Warbling Vireo, White-crowned Sparrow and Wilson's Warbler) were primarily in cutover sites with few trees, but rather well-developed hardwood shrub cover. When some tree cover appears and the shrub layer grows taller (higher total foliage volume), conditions improve for birds seeking taller hardwood cover (Black-headed Grosbeak), elevated hunting perches over open area (Willow Flycatcher), or dense overhead cover for protection of ground feeders (Fox Sparrow, Lincoln's Sparrow). Also, birds of the more developed forest now move out into these open areas as the tree cover increases (Golden-crowned Kinglet, Western Tanager, etc.).

With increasing total foliage volume (increasingly developed tree layer), early stage birds drop out and additional forest birds appear (Yellow-bellied

Table 8. Presence of breeding birds within classes of increasing total foliage volume.

Breeding Bird Species	Total Foliage Volume (m^3/.01h) 1 (0-100)	2 (100-250)	3 (250-500)	4 (500-1000)	5 (1000-1250)	6 (1250-1500)	7 (1500)
MacGillivray's Warbler	X	X					
Warbling Vireo	X	X	X				
White-cr. Sparrow	X	X	X				
Wilson's Warbler	X	X	X	X	X	X	
Black-headed Grosbeak		X					
Willow Flycatcher		X	X				
Lincoln's Sparrow		X	X	X			
Fox Sparrow		X	X	X	X		
Golden-cr. Kinglet		X	X	X	X	X	X
Western Tanager		X	X	X	X	X	X
Dark-eyed Junco		X	X	X	X	X	X
Swainson's Thrush		X	X	X	X	X	X
Townsend's Warbler		X	X	X	X	X	X
Yellow-bellied Sapsucker			X	X			
Chipping Sparrow			X	X	X		
Ruby-crowned Kinglet			X	X	X	X	
Red-breasted Nuthatch				X	X	X	X
Mountain Chickadee				X		X	X
No. Spp.	4	13	14	13	10	9	7

Sapsucker, Ruby-crowned Kinglet, and Mountain Chickadee).

It is interesting to note that areas of moderate foliage volume (100 - 1000 m^3/.01h) attract the largest number of different species (13 to 14).

More detailed examination of the habitat preferences of breeding birds is facilitated by the preparation of a series of habitat structural gradients on which the mean values for the structural characteristic within the territory of each bird species are plotted. These gradients are presented in Figures 3 and 4.

The total foliage volume ordination is similar to the distribution in Table 8, except mean values are shown rather than simply presence. As would be expected, birds attracted to open habitats (clearcuts, etc.), e.g. MacGillivray's Warblers, Willow Flycatchers, White-crowned Sparrows, and Lincoln Sparrows are found in areas of lower total foliage volume (0 to 600 m^3/.01h). Warbling Vireos and Black-headed Grosbeaks are also found in this range. They are probably not seeking openings, but rather are attracted to the hardwood cover found in the openings. Wilson's Warblers and Fox Sparrows are found in areas with slightly more foliage cover. Ruby-crowned Kinglets and Yellow-bellied Sapsuckers are also in this mid-range.

Dense foliage areas attract the typical forest birds, i.e. Red-breasted Nuthatches, Mountain Chickadees, Golden-crowned Kinglets, Western Tanagers, Townsend's Warblers and Swainson's Thrushes. Chipping Sparrows and Dark-eyed Junco's also frequent dense foliage areas, generally utilizing small openings among the trees. The ordination for total tree foliage volume is very similar.

The conifer foliage and deciduous foliage volume gradients confirm the relationships described above. The low total foliage volume birds are found in areas of high deciduous foliage volume and low conifer foliage volume which, in western Montana, means opening and cutover areas. Birds favoring high total foliage volumes are found in areas of high conifer foliage volumes, i.e. the forested sites.

The attraction of shrub areas (primarily found in openings) is again depicted

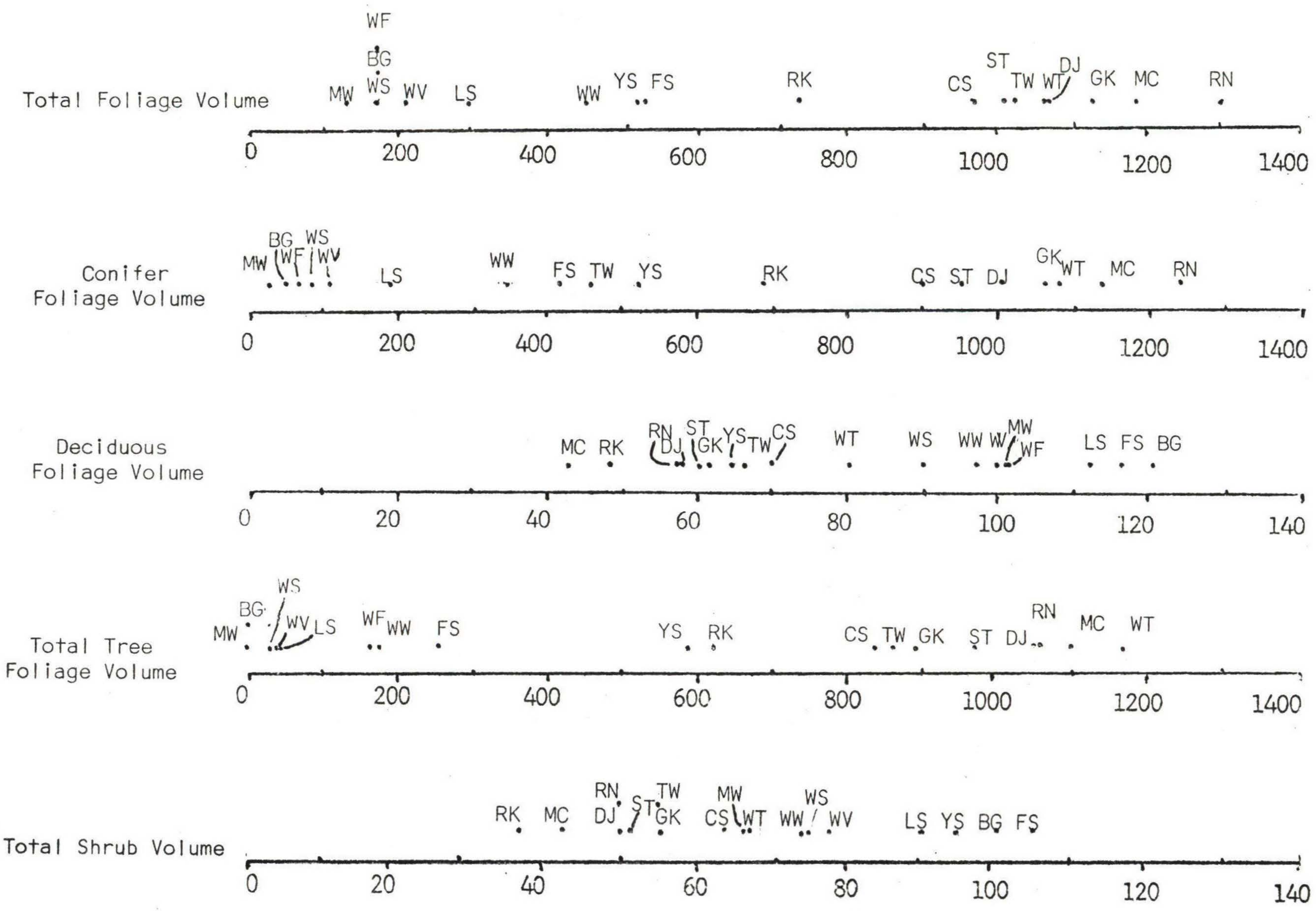


Figure 3. Mean values of habitat structural characteristics within breeding bird territories.

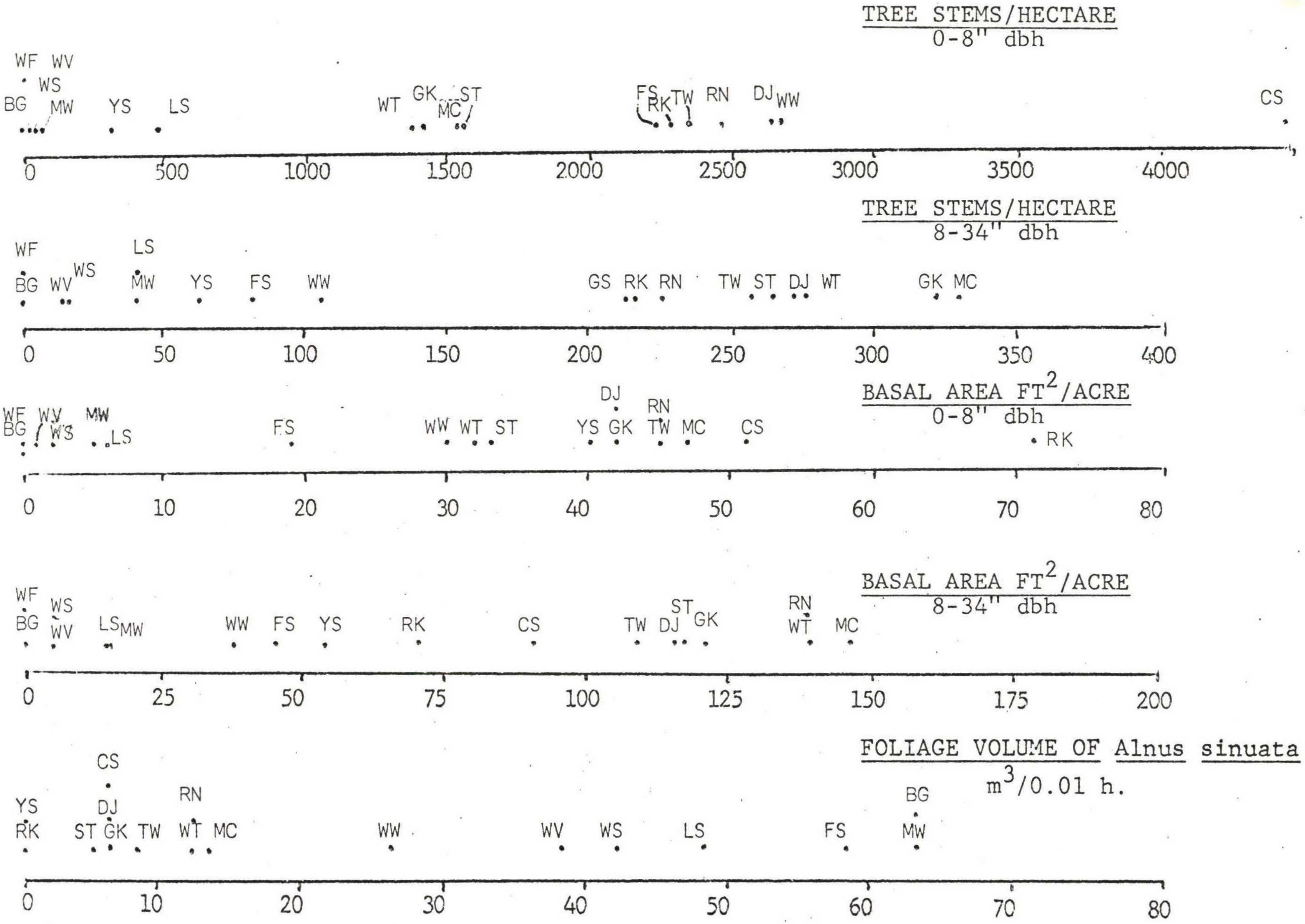


Figure 4. Mean values of habitat structural characteristics within breeding bird territories.

on the shrub foliage volume gradient. The conifer forest birds are on the low end of the distribution (lower shrub volumes), while the deciduous foliage or open area birds occur on the higher shrub volume sites.

Shrub stands in cutover areas and stream bottoms (generally the more dense shrub habitats) are often dominated in the study areas by Alnus sinuata. A plotting of bird habitats on the Alnus foliage volume gradient shows most birds favoring high shrub or deciduous foliage volumes are in areas supporting higher volumes of Alnus. Conifer forest species logically show very low attraction to Alnus, since it is less likely to be found within dense conifer forest. Several species found in areas of moderately high shrub volume (Yellow-bellied Sapsucker, Western Tanager and Chipping Sparrow, for example) show almost no relationship to Alnus. They are forest birds in areas where the shrub cover was probably Menziesia, Amelanchier, or Vaccinium.

Tree stem density gradients further clarify the foliage volume or successional stage relationships. Obviously, areas with few stems/hectare (open areas) are where you find Willow Flycatchers, Black-headed Grosbeaks, White-crowned Sparrows, and McGillivray's Warblers. Wilson's Warblers and Fox Sparrows occurred where smaller diameter stems (0-8" dbh) were very dense (2500+/hectare), but where large stems (8+) were rather sparse. It is likely this condition is met for these species by small groups of dense tree stems in otherwise relatively open site.

Swainson's Thrushes, Western Tanagers, Golden-crowned Kinglets and Mountain Chickadees selected areas where larger diameter trees (8-34" dbh) were most dense, and smaller stems only moderately dense. Townsend Warblers, Red-breasted Nuthatches, Dark-eyed Juncos, Chipping Sparrows, and Ruby-crowned Kinglets preferred stands with the higher densities of both small and large diameter trees. Relationships for basal area gradients resemble those for tree stem density.

Relationships of foraging guilds to study areas

In Table 9, the bird species breeding in each of the eight study areas are classified according to foraging guilds.

The clearcut area (Site VI) supports bird species adapted by foraging behavior to open areas and low shrub cover. White-crowned and Lincoln's Sparrows forage on the ground for seeds, Warbling Vireos, Wilson's Warblers, and Black-headed Grosbeaks search the low shrub foliage for insects, while Willow Flycatchers utilize the open space above the shrubs for air sallys after flying insects.

As the tree cover develops over the shrub layer (Site IV) and total foliage volume increases, the air sally and foliage-glean/omnivore guilds drop out. The air sally guild (Willow Flycatcher) perhaps finds the overhead cover too dense for air foraging or the change in plant cover may reduce the availability of airborne insects. The loss of the foliage-glean/omnivore (Black-headed Grosbeaks) cannot be easily explained unless related to the reduced availability of deciduous foliage.

Development of a mature forest with reduced shrub layer (Sites I, II, V) produces several guild additions: Bark-glean/Insect (Red-breasted Nuthatch), Ground-glean/insect (Swainson's Thrush and Chipping Sparrow) and Bark-drill (Yellow-bellied Sapsucker). Several new species are added to the foliage-glean/insect guild.

One species (MacGillivray's Warbler) joins the Foliage-glean/insect guild and one new guild, Ground-glean/omnivore (Fox Sparrow) is added. Under mature forest condition (Sites I, II, V, IX, and III) the tree canopy closes and understory shrub cover is reduced. When these structural changes occur, a considerable readjustment of foraging guilds and bird species takes place. The Ground-glean/seed guild continues to be present although represented in mature forests almost exclusively by the Dark-eyed Junco. The Foliage-glean/insect guild expands with the addition of five more species (Townsend's Warblers, Golden-crowned

STUDY AREA

	Cutover		Pole (Lodgepole pine)	Mature			Old Growth	
Foraging Guild	VI	IV	VII	I	II	V	IX	III
Air Sally	WF							
Foliage Glean - 0	BhG							
Ground Glean - S	WS → LS			DJ →	LS			
Foliage Glean - I	WV → WW →	MW		TW → GK	WW →	GK → RK WT →	MC	WW
Ground Glean - 0		FS			FS			FS
Bark Glean - I					RbN			RbN
Ground Glean - I				ST →	CS		CS →	ST
Bark Drill - 0				YbS				
No. of Guilds	4	3	--	4	5	3	3	5
No. of Species	6	5	--	5	8	7	6	9

Table 9. Bird foraging guilds and species found breeding on each study area.

and Ruby-crowned Kinglets, Western Tanager, and Mountain Chickadee) while losing the Warbling Vireo.

The Ground-glean/omnivore guild is still present, irregularly represented only by the Fox Sparrow. Three new guilds appear in the mature forest: The Bark-gleaners (Red-breasted Nuthatch), Ground-gleaners/insects (Swainson's Thrush, Chipping Sparrow) and, at one site only, the Bark-drill guild (Yellow-bellied Sapsucker).

DISCUSSION

A considerable array of literature is now available supporting the theory that, to a large degree, birds use the structural arrangement of the vegetation as cues to the presence of suitable breeding habitat. In addition, it is well-known that each bird species belongs to a specific foraging guild, i.e., it feeds in certain places, for a particular type of food, and with a consistent foraging technique. Each of these behavioral combinations or guilds is better suited for application within some vegetation structural types than in others.

In this study, breeding bird communities were related to Habitat Types, successional stages, and vegetation structural arrangements within the Abies lasiocarpa habitat type series. The bird species relationships to various successional stages and structural gradients can be explained, at least in general, by the birds' foraging guild membership or foliage structure preference.

It is much more difficult to explain the bird species relationships within Habitat Types. The Habitat Type concept classifies sites on the basis of their potential capability of producing similar climax plant communities. Several sites may currently be occupied by quite different forest cover types, yet still be capable of eventually supporting the same climax type. Thus, these presently dissimilar sites would be classified as the same Habitat Type. Conversely, several sites may currently be very similar in cover type and be classified as different climax Habitat Types.

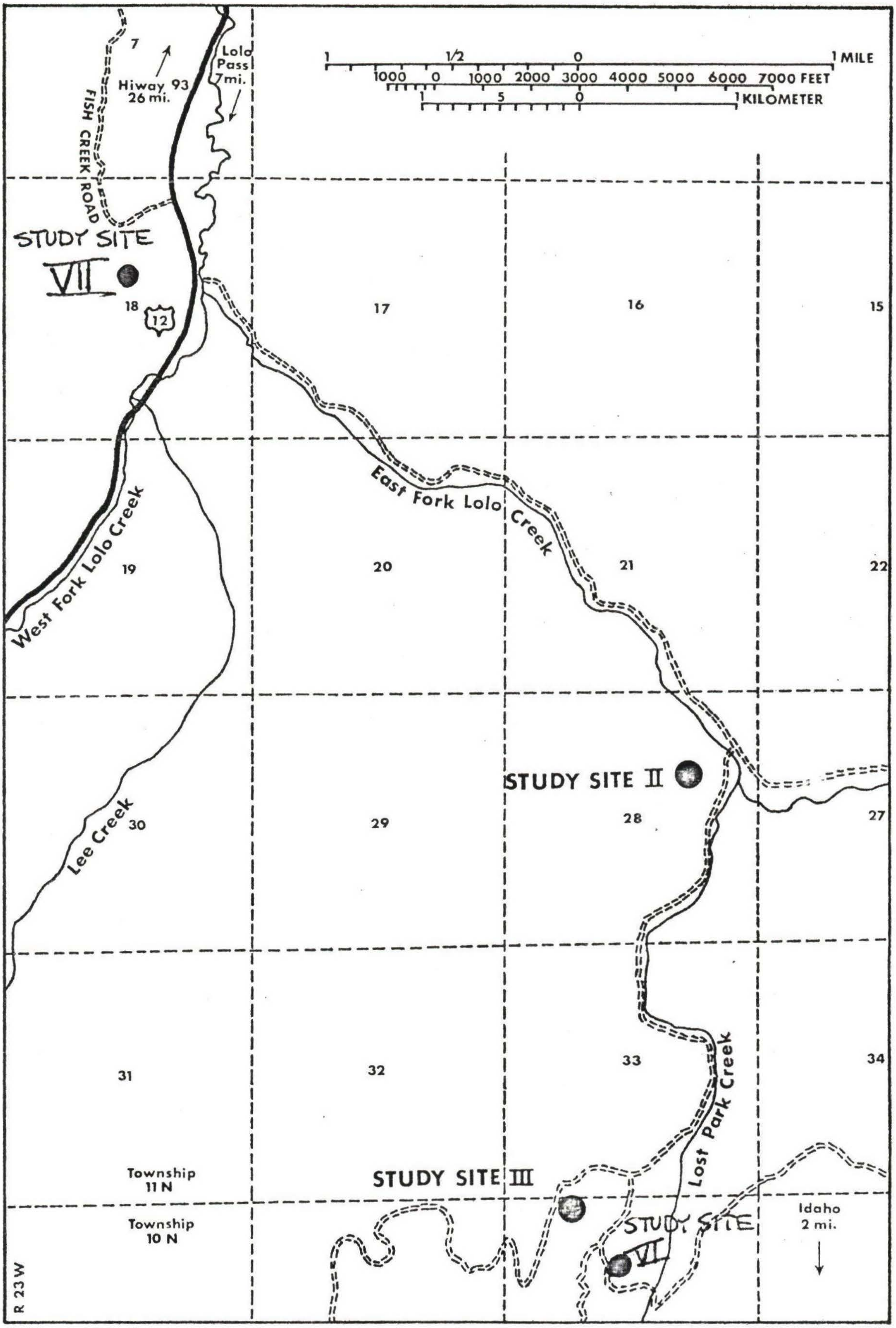
One would expect a bird species to be primarily affected by the nature of the current vegetation type (structure) and not by the potential vegetation climax (unless the site is at climax already). Yet the data presented in this paper do illustrate apparent interactions between bird species and Habitat Types.

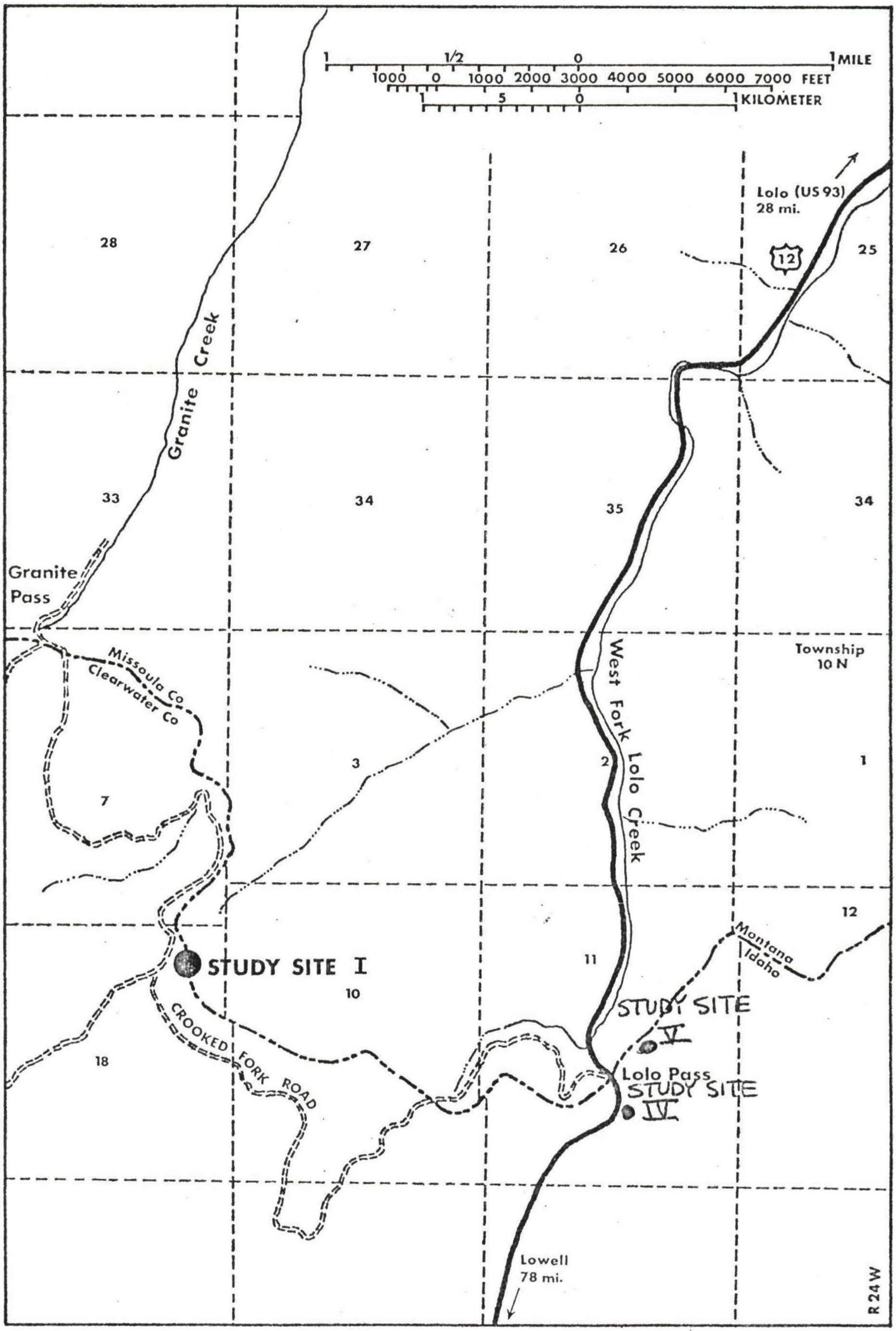
A possible explanation is the Habitat Type of a site influences the structural character of any seral stage occupying that site. This effect would be related not to the specific climax habitat type per se, but, rather, to its position on a scale of vegetation productivity. For example, Habitat Types categorized as highly productive might be expected, at any seral stage, to support more foliage volume, a more developed shrub layer, or more stems per hectare, than would Habitat Types classified as less productive.

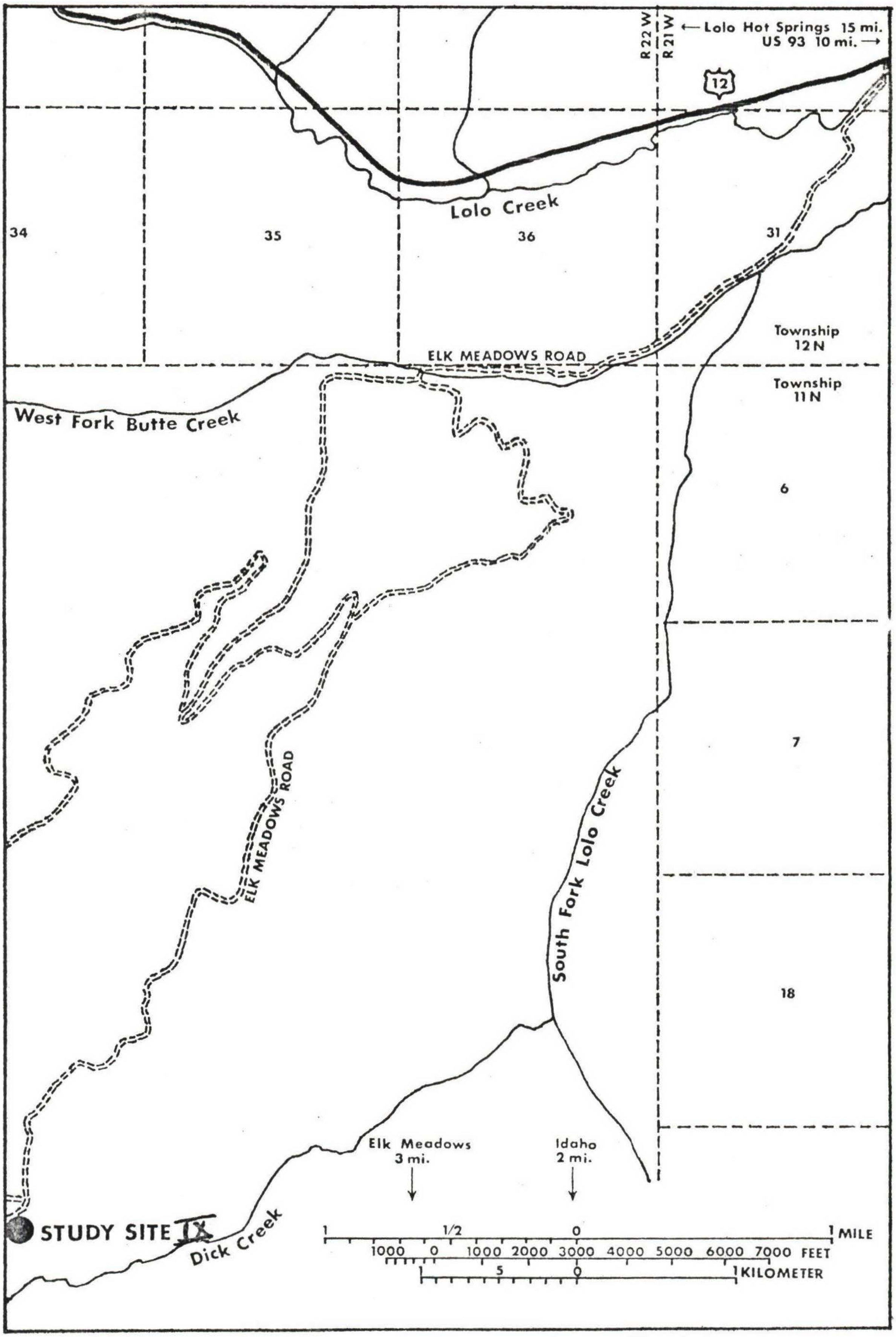
The data presented in this study are, by no means, sufficient to allow accurate prediction of bird communities to be expected in any particular subalpine fir Habitat Type in western Montana. However, interactions between bird communities and Habitat Types have been demonstrated. The precise nature of these relationships should receive further study.

APPENDIX A

STUDY AREA LOCATION MAPS


1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
7
Hiway 93
26 mi.
Lolo
Pass
7mi.
FISH CREEK ROAD
STUDY SITE
VII
18
12
17
16
15
East Fork Lolo Creek
West Fork Lolo Creek
19
20
21
22
STUDY SITE II
Lee Creek
30
29
28
27
31
32
33
34
Lost Park Creek
Township
11 N
Township
10 N
STUDY SITE III
STUDY SITE
VI
Idaho
2 mi.
R 23 W


1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 5 0 1 KILOMETER
Lolo (US 93) 28 mi.
12
28
27
26
25
Granite Creek
33
34
35
34
Granite Pass
Missoula Co
Clearwater Co
West Fork Lolo Creek
Township 10 N
7
3
2
1
12
Montana
Idaho
STUDY SITE I
10
11
STUDY SITE V
Lolo Pass
STUDY SITE IV
18
CROOKED FORK ROAD
Lowell 78 mi.
R 24 W


R 22 W
R 21 W
← Lolo Hot Springs 15 mi.
US 93 10 mi. →
12
Lolo Creek
34
35
36
31
ELK MEADOWS ROAD
Township 12 N
Township 11 N
West Fork Butte Creek
6
7
18
ELK MEADOWS ROAD
South Fork Lolo Creek
Elk Meadows 3 mi.
Idaho 2 mi.
STUDY SITE IX
Dick Creek
1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

APPENDIX B

STAND TABLES FOR EACH STUDY AREA

STAND VI

	STEMS/ACRE							BASAL AREA (Ft.^{2}/Acre)		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	2	5	2	0	0	0	9	1	0	1
LP	21	40	12	4	0	0	77	4	0	4
DF	0	0	0	0	0	0	0	0	0	0
ES	94	59	5	0	0	0	158	4	0	4
WL	2	3	4	0	0	0	9	0	0	0
TOT	119	107	23	4	0	0	253	9	0	9

STAND IV

	STEMS/ACRE							BASAL AREA (Ft.^{2}/Acre)		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	0	8	22	10	0	0	40	5	9	14
LP	0	0	0	0	0	0	0	0	0	0
DF	0	0	0	0	0	0	0	0	0	0
ES	69	5	5	4	0	0	83	2	3	5
WL	0	0	0	0	0	0	0	0	1	1
TOT	69	13	27	14	0	0	123	7	13	20

STAND VII

	STEMS/ACRE							BASAL AREA (Ft.^{2}/Acre)		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	24	11	0	0	0	0	35	1	0	1
LP	1568	753	164	6	0	0	2491	78	5	83
DF	48	0	0	0	0	0	48	0	0	0
ES	0	0	0	0	0	0	0	0	0	0
WL	0	35	24	12	3	0	74	6	20	26
TOT	1640	799	188	18	3	0	2648	85	25	110

STAND I

	STEMS/ACRE						BASAL AREA (Ft.^{2}/Acre)		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	0	66	37	24	0	0	127	11	21	32
LP	92	46	83	43	1	0	265	19	39	58
DF	0	0	0	0	0	0	0	0	0	0
ES	0	0	36	39	1	0	76	7	36	43
WL	0	0	0	0	0	0	0	0	0	0
TOT	92	112	156	106	2	0	468	37	96	133

STAND II

	STEMS/ACRE							BASAL AREA (Ft.^{2}/Acre)		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	764	224	99	29	0	0	1116	35	25	60
LP	244	61	37	2	0	0	344	12	2	14
DF	0	0	5	2	0	0	7	1	2	3
ES	0	20	28	31	1	0	80	7	29	36
WL	0	0	2	4	1	0	7	0	6	6
TOT	1008	305	171	68	2	0	1554	55	64	119

STAND V

	STEMS/ACRE							BASAL AREA $(Ft.^2/Acre)$		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	688	206	153	29	1	0	1077	44	27	71
LP	0	8	18	9	0	0	35	4	8	12
DF	0	0	0	1	0	0	1	0	1	1
ES	183	41	64	35	4	0	327	16	41	57
WL	0	0	6	0	0	0	6	1	0	1
TOT	871	255	241	74	5	0	1446	65	77	142

	STEMS/ACRE							BASAL AREA (Ft.^{2}/Acre)		
SPP	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	145	118	62	16	1	0	342	19	16	35
LP	241	64	48	17	0	0	370	14	16	30
DF	145	16	35	34	8	0	238	8	53	61
ES	48	62	21	16	1	0	148	8	17	25
WL	0	0	1	4	1	0	6	0	6	6
TOT	579	260	167	87	11	0	1104	49	108	157

STAND III

SPP	STEMS/ACRE							BASAL AREA (Ft.^{2}/Acre)		
	0-2	2-4	4-8	8-15	15-30	30+	TOT	0-8	8-34	TOT
AF	389	37	14	7	1	0	448	7	7	14
LP	0	0	0	5	0	0	5	0	5	5
DF	0	0	0	6	6	1	13	0	26	26
ES	0	19	25	47	22	0	113	6	101	107
WL	0	0	2	7	13	0	22	0	46	46
TOT	389	56	41	72	42	1	601	13	186	199